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Now, if the function  $u$  be assumed of such value as to make the factor  $z$  in this equation vanish, we shall have the two equations,

$$\frac{du}{dx} + u \log x = 0, \text{ and } u \frac{dz}{dx} = ax^{-x}.$$

From the former, we get by integration,  $u = e^x x^{-x}$ , and the value of  $u$  reduces the latter to  $e^x \frac{dz}{dx} = a$  or  $dz = ae^{-x} dx$ . Whence  $z = -ae^{-x} + C$ .

Therefore  $y = uz = e^x x^{-x} (-ae^{-x} + C) = x^{-x} (Ce^x - a)$ , which is the required solution.

Also solved by *L. C. WALKER, G. B. M. ZERR, F. P. MATZ, and J. SCHEFFER.*

131. Proposed by *F. P. MATZ, Sc. D., Ph. D., Professor of Mathematics and Astronomy in Defiance College, Defiance, Ohio.*

Integrate  $2/r$ , with regard to  $d[1/(1-x^2)]$ .

Solution by the PROPOSER.

According to the conditions of the problem, we may write  $d[F(x)]/d[1/(1-x^2)] = 2/x \dots (1)$ .

$$\therefore F(x) = 2 \int \frac{d[1/(1-x^2)]}{x} = -2 \int \frac{dx}{1/(1-x^2)} = \sec^{-1} \left[ \frac{1}{2x^2-1} \right]$$

$= \cos^{-1}(2x^2-1) \dots (2)$ , which is the integral required.

Also solved with various results by *H. C. WHITAKER, J. SCHEFFER, and G. B. M. ZERR.*

132. Proposed by *JOHN M. COLAW, A. M., Monterey, Va.*

What expression derived from the *polar* equation of a curve is equivalent to the expression for  $dy/dx$  derived from the *Cartesian* equation of the same curve? Prove work with  $\rho = 2r \cos \theta$ .

Solution by *LON C. WALKER, A. M., Professor of Mathematics, Petaluma High School, Petaluma, Cal.*

Let  $x = \rho \cos \theta$ ,  $y = \rho \sin \theta$ , then

$$\frac{dy}{dx} = \frac{\sin \theta (d\rho/d\theta) + \rho \cos \theta}{\cos \theta (d\rho/d\theta) - \rho \sin \theta} \dots (1).$$

From  $\rho = 2r \cos \theta$ , we get  $d\rho/d\theta = -2r \sin \theta$ . Substituting this value of  $d\rho/d\theta$  in (1), and reducing, we have

$$\frac{dy}{dx} = \frac{r-x}{y} \dots (2).$$

Now substituting the value of  $x$  and  $y$  in  $\rho = 2r \cos \theta$ , we get  $x^2 + y^2 = 2rx$ ; from which  $dy/dx = (r-x)/y$ , the same as in (2).

The angle the tangent makes with the radius vector is  $\rho(d\theta/d\rho)$ , which is often used in the same way as  $dy/dx$ ; for instance, in trajectories, etc.

Also solved by *G. B. M. ZERR*, and *J. SCHEFFER*.

# MECHANICS.

130. Proposed by *W. J. GREENSTREET*, M. A., Editor of *The Mathematical Gazette*, Stroud, Gloucestershire, England.

Two particles are projected from *A* and *B* on the same level at  $\alpha, \beta$  to horizon, and in vertical planes with which *AB* makes angles  $\theta, \varphi$ . They meet and coalesce into a single particle. Find the height of the latus rectum of the subsequent path above the level of *A* and *B*.

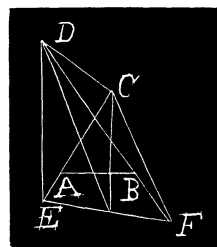
Solution by *G. B. M. ZERR*, A. M., Ph. D., Professor of Chemistry and Physics in The Temple College, Philadelphia, Pa.

Let *D* be the point of meeting of the two particles; mass of each, unity; *C*, the projection of *D* on the plane of *AB*; *DE*, *DF*, the tangents to the two paths, respectively; *G*, the mid-point of *EF*. Then *DG* is the direction of the resultant of *DE* and *DF*. Let *AB*= $a$ ,  $\angle CAB = \theta$ ,  $\angle CBA = \varphi$ .

Then  $AC = a \sin \theta / \sin(\theta + \varphi)$ ,  $BC = a \sin \varphi / \sin(\theta + \varphi)$ .

The equation to the path through *AD* is  $m = n \tan \alpha - gn^2 / 2v^2 \cos^2 \alpha$ , when  $n = a \sin \theta / \sin(\theta + \varphi)$ .

$$m = \frac{a \sin \theta \tan \alpha}{\sin(\theta + \varphi)} - \frac{ga^2 \sin^2 \theta}{2v_1^2 \sin^2(\theta + \varphi) \cos^2 \alpha} = h \dots (1).$$



The equation to the path through *BD* is  $p = q \tan \beta - gq^2 / 2v_1^2 \cos^2 \beta$ , when  $q = a \sin \varphi / \sin(\theta + \varphi)$ ;

$$p = \frac{a \sin \varphi \tan \beta}{\sin(\theta + \varphi)} - \frac{ga^2 \sin^2 \varphi}{2v_1^2 \sin^2(\theta + \varphi) \cos^2 \beta} = h \dots (2).$$

From (1) and (2),

$$v_1^2 = \frac{agv^2 \sin^2 \varphi \cos^2 \alpha}{\cos^2 \beta [ga \sin^2 \varphi + 2v^2 \cos^2 \alpha \sin(\theta + \varphi) (\sin \varphi \tan \beta - \sin \theta \tan \alpha)]}.$$

$$\tan DEC = dm/dn = \tan \alpha - gn/v^2 \cos^2 \alpha = \tan A.$$

$$\therefore \tan A = \tan \alpha - \frac{ag \sin \theta}{v^2 \sin(\theta + \varphi) \cos^2 \alpha}; \tan DCF = \frac{dp}{dq} = \frac{\tan \beta - gq}{v_1^2 \cos^2 \beta} = \tan B.$$

$$\therefore \tan B = \tan \beta - \frac{ag \sin \varphi}{v_1^2 \sin(\theta + \varphi) \cos^2 \beta}.$$